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A NOTE ON THE USE OF ULTRAVIOLET LAMPS IN MINES FOR RAPID DETECTION OF SCHEELITE IN ORES BY FLUORESCENCE

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A NOTE ON THE USE OF ULTRAVIOLET LAMPS IN MINES FOR RAPID DETECTION OF SCHEELITE IN ORES BY FLUORESCENCE[1]

By William O. Vanderburg[2]

INTRODUCTION

The fluorescence of many minerals, when excited by different wave lengths of ultraviolet radiation, has long been recognized as a spectacular laboratory phenomenon. Since the original display in the British Museum, the phenomenon has been used frequently for educational purposes and public demonstrations. Its practical application for the rapid detection of certain minerals in ores and mill products at the zinc mine at Franklin, N.J., has been described.[3]

Due to technical improvements in ultraviolet-radiation apparatus, fluorescence has found a new field of application in the tungsten-mining industry. Although fluorescence of scheelite (calcium tungstate) has been known for a number of years, the practical application of the phenomenon is the outgrowth of a program of cooperative research conducted by Ott F. Heizer, manager of the Nevada-Massachusetts Co., Inc., Mill City, Nev., and Dr. Paul F. Kerr of Columbia University. Special portable lights for fluorescing scheelite have been developed and utilized in underground geological work.

Thanks are due Ott F. Heizer for permission to publish data included in this paper.

APPARATUS FOR PRODUCING ULTRAVIOLET RADIATION

There are several models of ultraviolet lamps on the market that have been designed for specific purposes, but the most satisfactory one for producing fluorescence in scheelite is the so-called "strong arc." It is similar in design to the outfit originally described by Andrews.[4]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6873."

[2] Mining engineer, U.S. Bureau of Mines.

[3] Palache, Charles, The Phosphorescence and Fluorescence of Franklin Minerals: Am. Mineral., vol. 13, no. 7, 1928, pp. 330-333.

[4] Andrews, W. S., Apparatus for Producing Ultraviolet Radiation: Gen. Elec. Rev., vol. 19, 1916, pp. 317-319.

Original from THE OHIO STATE UNIVERSITY

A lamp of this type may be purchased for $35, or one may be built at a cost of $12 to $35, depending on the refinements of construction. The outfit can be connected to any 110-volt alternating current circuit. A sketch of the lamp and the wiring diagram is shown in figure 1.

The apparatus consists of three principal parts, which are as follows:

1. A small transformer that steps up 110-120 volt alternating current to 4,500 volts.

2. A mica condenser that has a capacity of 0.004 microfarad at 3,500 volts.

3. A spark gap with adjustable and replaceable iron electrodes.

The above parts, with accessories such as switch, wiring, terminal posts, and receptacle for spark gap, are installed in a neat wood box. The outfit weighs about 18 pounds.

The spark gap is enclosed in a cylindrical chamber of bakelite for insulation and for protecting the eyes of the operator.

It is important, when working with the instrument, that the eyes be shielded from the invisible but none the less injurious ultraviolet radiation. Exposure of the eyes to ultraviolet radiation from electric arc lamps or electric welding outfits causes conjunctivitis, which is an inflammation of the muccous membrane covering the lining of the inside of the eyelid and part of the eyeball.[5]

When the connecting cord of the apparatus is plugged into a suitable current outlet and the spark gap adjusted to about 1/8-inch, the instrument is ready for use.

A portable light similar to the one described, but equipped with a quartz projecting lens, is employed at the tungsten properties of the Nevada-Massachusetts Co., Inc. This type of lamp was designed particularly for the detection of scheelite in mining operations.

The high tension disruptive spark between iron terminals produces an intense spark without flame. The spark is particularly rich in radiation in the ultraviolet region of the spectrum - roughly, from 4,270 to 2,100 Ångstrom units. Although the iron arc emits both visible and invisible radiation, the proportion of visible radiation is low enough to permit efficient use without a filter.

APPLICATION OF THE ULTRAVIOLET LAMP IN TUNGSTEN MINING

When the ultraviolet radiation impinges upon certain minerals, the minerals become fluorescent and glow with various colors. Scheelite, the most important tungsten mineral mined in the United States, is capable of absorbing ultraviolet radiation and transforming this radiation into colors of longer wave length in the visible spectrum. Most scheelite fluoresces a light blue under the iron spark. The fluorescence can be seen in a lighted room or in the shade in daylight; however, it shows to best advantage in a dark room, and it is particularly striking in the total darkness of underground workings.

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[5] Kindall, C. R., Effect of Ultraviolet Rays on the Eyes: Rept. of Investigations 2173, Bureau of Mines, 1920, 2 pp.

The color of fluorescence is peculiar to the ore examined, and since color is a simple means of identification, it furnished a rapid and reliable method for the qualitative as well as approximate quantitative determination of scheelite in ores and mill products. This method of increasing the sense of vision is advantageous with scheelite because in ordinary light with the unaided eye it is difficult to distinguish scheelite from minerals ordinarily associated with it, such as quartz and calcite.

In concentrating scheelite ores the instrument is useful in estimating the percentages of scheelite in jig, concentrating-table, and magnetic separator products to test the efficiency of the various machines. A sample of the dried material is placed under the spark lamp, and the amount of scheelite in the sample can be approximated by its fluorescence. On the finer-mesh material the fluorescence of scheelite does not show as readily in a lighted room as on the coarser material. A dark room is necessary for the best results. Due to the fact that chemical methods of assying for tungsten are slow and expensive, chemical methods of assaying are seldom, if ever, used in routine mill-control work at tungsten concentrators. Ordinarily, methods based on the specific gravity of the tungsten minerals are employed. In the case of scheelite, the ultraviolet apparatus is more rapid than panning, and, because of the greater area available for exposure, gives a better average.

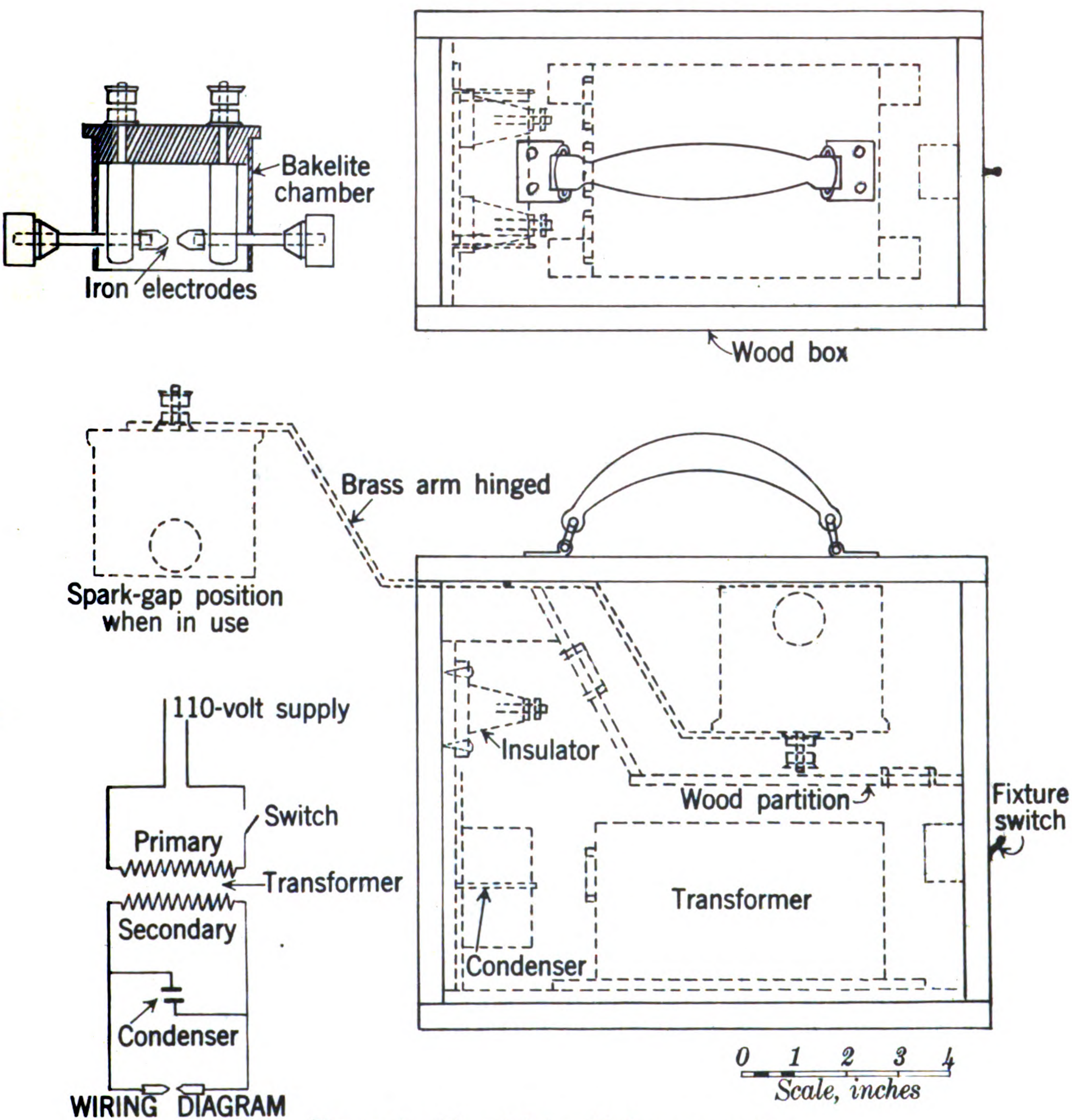

Figure 1.—Ultraviolet radiation apparatus.